Name: _key_ .

1. The diagram shows the vectors $\overrightarrow{PQ} = \langle 1, 3 \rangle$ and $\overrightarrow{PR} = \langle 5, 2 \rangle$. The angle between them is θ. The vector $\overrightarrow{PS}$ is the vector projection of $\overrightarrow{PQ}$ onto $\overrightarrow{PR}$.

[4] a) Find $\cos \theta$.

$$\cos \theta = \frac{\overrightarrow{PQ} \cdot \overrightarrow{PR}}{|\overrightarrow{PQ}| \cdot |\overrightarrow{PR}|} = \frac{1 \cdot 5 + 2 \cdot 3}{\sqrt{10} \sqrt{29}} = \boxed{\frac{11}{\sqrt{10}\sqrt{29}}}$$
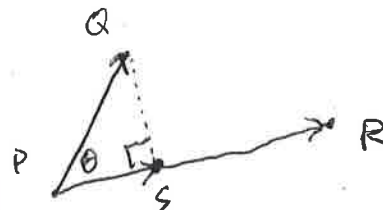
[4] b) Find the number $|\overrightarrow{PS}|$.

$$|\overrightarrow{PS}| = |\overrightarrow{PQ}| \cos \theta = \sqrt{10} \cdot \left(\frac{11}{\sqrt{10}\sqrt{29}} \right) = \boxed{\frac{11}{\sqrt{29}}}$$

[4] c) Find a unit vector (i.e., a vector with magnitude 1) which points in the same direction as $\overrightarrow{PR}$.

a unit vector in the direction of $\overrightarrow{PR}$ is $\vec{u} = \dfrac{\overrightarrow{PR}}{|\overrightarrow{PR}|} = \dfrac{\langle 5, 2 \rangle}{\sqrt{29}}$

$$= \langle \tfrac{5}{\sqrt{29}}, \tfrac{2}{\sqrt{29}} \rangle$$

[4] d) Find the vector $\overrightarrow{PS}$.

$\overrightarrow{PS}$ is in the same direction as the unit vector $\vec{u}$ from point c)

and has length $\dfrac{11}{\sqrt{29}}$, so it equals $\dfrac{11}{\sqrt{29}} \vec{u}$, or $\dfrac{11}{\sqrt{29}} \langle \tfrac{5}{\sqrt{29}}, \tfrac{2}{\sqrt{29}} \rangle =$

$$= \langle \tfrac{55}{29}, \tfrac{22}{29} \rangle$$

[4] **2.** Let $\mathbf{a} = 3\mathbf{i} + \mathbf{k}$ and $\mathbf{b} = \mathbf{i} - 2\mathbf{j} + 3\mathbf{k}$. Find $\mathbf{a} \times \mathbf{b}$, showing your work.

$$\vec{a} \times \vec{b} = \begin{vmatrix} \vec{i} & \vec{j} & \vec{k} \\ 3 & 0 & 1 \\ 1 & -2 & 3 \end{vmatrix} = \vec{i}(0 \cdot 3 + 2 \cdot 1) - \vec{j}(3 \cdot 3 - 1 \cdot 1) + \vec{k}(3(-2) - 0 \cdot 1)$$

$$= \boxed{2\vec{i} - 8\vec{j} - 6\vec{k}}$$